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THERMITE COATING PROCESS

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2 Claims. (Cl. 117—50)

The present invention relates to a method of rapid and cheaply plating metal.

The present application is a division of my copending application, Serial No. 484,479, filed April 24, 1943, now Patent No. 2,463,342 and the claims herein are directed to thermite coating without hot working as claimed in the parent application.

It is an object to plate various metals for example any stable metal or alloy less active in the electromotive series than the alkali metals upon a base metal. The base metal may consist of any solid metal or alloy of general electrical or mechanical use which is desired to be plated and which will withstand high coating temperatures without completely fusing.

It is a further object to apply the metal plate as a chemical mixture of a compound of the plating metal with other substances which will react when heat is applied to form the free metal to be plated.

It is a further object to use a base metal that is in a heated state during some period of its fabrication and use this heat to activate a chemical mixture of the plating substance whereby free metal is produced and plated in situ on the base metal.

It is a further object to effect the plating in a manner to remove impurities, such as scale, from the surface of the base metal while it is being plated.

It is a further object to accomplish the plating under conditions of temperature, pressure and fluxes whereby the plating metal is mechanically distributed and pressed upon the surface of the base metal to effect a permanent coating therewith during some normal metal fabrication operation.

Further objects will be inherent in the process as described and will be apparent to one skilled in this art from the description given.

The base metal will be any metal adapted to carry out the function of the structure either entirely or in part. The plating metal will be adapted either to modify the stability or corrosive properties of the base metal; the function or hardness of the surface for example to improve wearing properties such as by coating with soft bearing metal where the function will be as a bearing or bushing, or with a hard cutting or wearing surface for dies, tools or rubbing surfaces; or with a highly electric conducting or resistive properties of the base metal where desired electrical properties are to be enhanced as in wire coating or with a refractory metal where heat and oxidation are to be resisted.

The mixture of chemicals comprising the plating mixture will be adjusted to give a stoichiometric reduction of the metal to be plated. The mixture may contain an additional fluxing material to ensure proper adherence of the plating metal to the base metal. The base metal will be heated sufficiently to supply enough heat either to initiate the reaction of the chemicals applied to the surface, or to maintain the base metal in a pliable or soft state to allow fabrication while using auxiliary means to initiate reaction of the plating mixture.

Such temperature will vary for different reducing metals and different metal fabricating processes.

The chemical mixture will contain a compound, such as any reducible commercial ore of the metal to be plated out, preferably an oxide. This will be intimately mixed with a reducing agent such as a free metal more chemically active in the electromotive series than the metal to be plated out.

The chemical reactions may be shown as follows:

Plating tin

Taking tin ore from which tin is to be plated as the coating agent and metallic aluminum as the reducing agent:

$$4Al+3SnO_2=2Al_2O_3+3Sn$$

Plating copper

Using any common more active metal

$$2Al+3CuO=Al_2O_3+3Cu$$

$$Mg+CuO=MgO+Cu$$

An alloy may be plated where the active metal is in excess of the metal to be reduced from its oxide. For example a bronze from copper and tin, or from aluminum and copper are shown as:

$$2Sn+CuO=SnO+SnCu$$

$$5Al+3CuO=Al_2O_3+3AlCu$$

Obviously the proportions will be varied to obtain the desired alloy plate, the alloy examples being in proportions of 1 to 1 merely to show the method.

The same results may be obtained by use of a mixture of compounds with a reducing metal capable of reducing both:

$$2Al+SnO_2+CuO=Al_2O_3+SnCu$$

By proper adjustment of stoichiometric proportions any number of metals may be mixed in the plate as an alloy coating.

It is also possible to repeat the operation with different chemical mixes to obtain two platings superimposed one on the other:

$$2Al+Ni_2O_3=Al_2O_3+2Ni$$

This plate is then treated with the following mix to obtain a chromium plate on a nickel base.

$$2Al+Cr_2O_3=Al_2O_3+2Cr$$

It will be noted that the reducing metal must be not only more active than the plating metal but will usually be more active than the base metal, in which case any impurities, such as metal oxide scale on the base metal will also be reduced. Thus it is desirable in such condition to use a slight excess of the reducing metal.

It will also be apparent that the reaction between the reducing metal is much more active than the metal to be reduced, is usually highly exothermic, and the reduced metal produced on the surface of the base metal is in a super heated state often highly fluid and in the presence of the higher metal formed oxide tending to act as a flux readily coats the base metal surface.

Example I

In rolling steel plate the steel is heated first until it is soft and pliable. The steel slabs are applied to rollers to be rolled into plate. During this operation much scale, iron oxides, are formed and it is common to throw salt on the slabs being rolled to aid in the removal of scale, but the finished plate from ordinary steel does, notwithstanding, contain much scale on the surface.

According to the present process a highly desirable resistant metal plating, for example chromium, or other desirable coating may be applied to the hot steel plate being rolled whereby a scale free plate is produced.

While the steel plate is being passed under the rollers a mixture of active metal, for example aluminum, and an oxide of the metal to be plated, for example chromic oxide, is thrown on the white hot slab.

The heat of the steel being rolled initiates the reaction between the reducing metal aluminum and the chromium oxide as well as any iron oxide scale on the steel, forming free molten chromium metal and aluminum oxide which acts as a flux. The passage up and back under the rollers distributes and heavily presses the molten chromium evenly over the steel to form a coating. Some of the molten alumina will be rubbed off in the operation but any finally adhering alumina is additional protection. It may ultimately be removed by pickling, grinding or polishing if desired.

This plating operation would be applied to both sides of the plate as it is turned over as is common while rolling.

Other metal coatings for example copper, cadmium, tin, vanadium, columbium, tantalum, tungsten, molybdenum, nickel, cobalt, manganese, or mixtures may be applied in a similar way. It is also possible to use additional hardening and fluxing materials to secure harder and more adherent plating. It will be appreciated that some of the highly refractory metals reduced will not be molten, but the softened surface of the steel produced in the reaction to which refraction is compressed under the heavy rollers will give an adherent coating.

It will be further appreciated that the reaction may be varied by using more or less active reducing metals. It will also be possible to secure a coating by use of a low grade ore of the metal to be reduced either as the pure metal or an alloy thereof. This method will be similarly applicable in fabricating metal strip, rails and discs.

Example II

Using an excess of metallic aluminum as a reducing agent and a beryllium salt or ore which has been freed of silica for example Al_2O_3,BeO or BeO alone.

An alloy of beryllium and aluminum is deposited on steel plate, when applied according to Example I. The beryllium need be present only in minor quantity up to 20 percent, usually 1–3% to give the desired properties to the plating. Such coating has hard wearing, non-fatiguing and non-sparking properties desirably imparted to the steel.

This composition may be repeated using the aluminum only in slight excess (as a reducing agent) and an additional oxide of a metal such as copper or nickel adjusted to give, with a small quantity of beryllium oxide or mixed aluminum beryllium oxides, an alloy of nickel or copper with a few percent of beryllium as the metal plate upon the steel.

Thus hot steel is plated by rolling with a powder formed by mixing about 65 parts of aluminum powder, 162 parts of nickel oxide Ni_2O_3 and 10 parts of beryllium oxide BeO, all parts by weight. This would give an alloy plate of approximately 98% nickel and 2% beryllium, with some impurities such as aluminum oxides, aluminum metal and other oxides. Where copper is substituted for nickel in a 2% beryllium alloy, the quantity of copper oxide would be about 77 parts in the above mixture. It will be apparent to any chemist that the quantities to be used may readily be calculated from the reaction which takes place and the alloy or metal desired as the plating.

If desired the plated sheets or plates may be laminated and joined together by welding the edges, spot welding or annealing to give a laminated structure of desired properties. Where the coated sheets or plates are to be laminated, they may first be pickled or otherwise cleaned of oxides and fluxes adhering to the plate.

Refractory or electroresistive or conductive metals may be applied to sheets of steel, and the steel subsequently rolled or welded into tubes having a heat or corrosion resisting or catalytic inner or outer surface; or an electric conducting or resistive surface. If desired the coated sheet may be cut into small buttons for electric contacts where the coating is of tungsten or molybdenum suitable for such use. While some of these metals are infusible per se the surface of the base metal will be sufficiently softened to bond the reduced refractory metal coating.

Example III

Metal base wire, such as hard metal wire or steel or other hard refractory metals nickel, molybdenum, tungsten, etc. may be given a coating of copper, silver, lead, zinc or chromium by passing the wire in a heated state rapidly thru a powdered reducing metal such as aluminum or magnesium and an oxide of one of these metals to be plated. The heated base metal wire will activate the chemical mixture to cause a deposit of one of these metals to coat the wire. The wire may be heated in short sections by an electric current contacting the wire before and after it is passed through the chemical mixture.

Tubes, pipes or rods may be coated with the chemical as the tube is formed by extrusion from a die or otherwise preheated.

It will be apparent that various base metals may be used as well as reducing metals, the latter being selected within the limits of its chemical capacity to reduce the metal to be plated.

Sometimes the oxidation product of the reducing metal may be the most desirable coating agent, such as in anodic oxidation to reduce corrosion as shown in the following:

Example IV

A heat rolled magnalium sheet is treated with a small quantity of aluminum or magnesium metal powder and an oxide of a metal which will slow down oxidation, such as boric oxide, and another oxide tending to form a slight coating, such as beryllium oxide, chromic oxide, nickel oxide, etc. Upon reaction the plating metal will be plated and alloyed with the surface of the light metal and a coating of noncorrosive magnesium or aluminum oxide will be formed.

Example V

White hot iron castings, cooled only enough to set, are coated with the composition described to give a desirable coating on surfaces to be left unfinished. A white hot casting, cooled only sufficient to harden, was treated on one surface only with a mixture of two parts by weight of chromic oxide and one part of aluminum powder. The powder was dusted evenly over this surface, a reducing reaction set up and moved evenly over the surface. After cooling the surface was brushed clean. The treated surface showed a hardness of 35–40 on the scleroscope and the treated surface burned a high speed cutting tool. The casting was subjected to corrosive baths and air. The untreated surfaces began to rust in a few days while the treated surfaces remained bright and clean.

Other compounds of the metal to be plated than the oxide, as they are more available commercially or as the reduction product may be more desirable, such as compounds with another radical may be used. For example hardening agents may be incorporated into the metal surface such as cyanides, cyanamids, carbides, or silicides of refractory metals.

Example VI

Steel plate, as rolled in Example I, is treated with a mixture of aluminum powder, tungsten oxide and an excess of free carbon adjusted in stoichiometric proportions to reduce the tungsten. The resulting product will be a mixture of free metals tungsten, aluminum oxide and tungsten iron and aluminum carbides. The aluminum carbide may be decomposed with water or acid and removed to leave a fused mixture of hard aluminum oxide, tungsten carbide on the base metal.

What I claim is:

1. Method of metal coating a high melting base metal comprising heating the base metal to white hot temperature sufficient to initiate a reaction in a finely divided mixture of an active reducing metal selected from the group consisting of aluminum, magnesium and alloys composed of aluminum and magnesium, and an oxide of a coating metal less active than the reducing metal, the active metal being in proportions at least sufficient to stoichiometrically reduce said oxide, and applying said mixture to the surface of the white hot base metal whereby exothermic reaction is initiated and a molten coating metal is released by the reaction over the surface of the base metal for coating the same.

2. The process of coating an iron casting which comprises, heating the casting until it is white hot, allowing the casting to cool just sufficiently to harden, evenly applying a mixture of two parts by weight of chromic oxide powder and one part by weight of aluminum powder to a surface of the hot casting, whereby a reaction occurs on the surface of the hot casting, between the chromic oxide and aluminum powder mixture to provide a metallic coating on the casting.

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